ADDITIONAL NOTES ON THE LIFE HISTORY OF BOMBUS AURICOMUS ROBT.

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During the summer of 1917 the writer was enabled to make some additional observations on the life-history of *Bombus auricomus* Robt., which resulted in the verification of several statements already published in a preceding article of his ('17), and in the addition of new facts of interest.

I. SPRING FLIGHT OF THE QUEENS.

The queens of *Bombus auricomus* in this vicinity began to fly in the spring of 1917 about the twelfth of May, and continued flying until about the first of July. The queen during the first few days of the spring flight flies rather near the ground, stopping now and then to sip the nectar from some attractive flower. Later this leisurely flight settles into an industrious search for a nesting site, the duration of the search depending entirely upon how soon the queen finds a favorable location. After a nesting site is once selected the queen busies herself mainly with collecting pollen in which to lay the eggs for her future brood.

From this time on, the flights of the queen from the nest gradually decrease in number, until at last there comes a time when sufficient workers have been produced to supply the necessary pollen and honey, and the queen seldom if ever leaves the nest. It is safe to say that nearly all the queens of this species in this vicinity in a normal season have started their nests by the first or second week in June.

II. METHODS USED IN STARTING A COLONY BY CONFINING THE QUEENS.

For several years I have tried confining bumblebee queens in separate artificial nests and feeding them, in the hope of getting the queens to start colonies, but this method has always failed. Sometimes a queen would seem to take an interest in the nest, pat the grass down about the pollen lump, and get very excited when disturbed, but always finally abandoned the nest. This season, however, I decided to try the placing of

two queens of the same species in the same nest, as Sladen ('12) did with the common European bumblebee, *Bombus terrestris* Linn.

On May 14, 1917, I caught one queen of *Bombus auricomus*, which I brought home and confined in an artificial nest. Another queen of the same species was caught a day later, and introduced into the same nest with the first queen. The wings of the latter queen were slightly notched before she was introduced into the nest, in order that I might distinguish her from the queen first introduced. The artificial nest used consisted of a small wooden box with a glass-sectioned top. In the box proper I had placed an old field-mouse nest, in which was a honey-moistened lump of honey-bee pollen. New pollen-lumps had to be placed in the nest from time to time, for the pollen when not worked by the queen soon dried out and became unfit for use. On June 13 a wax-pollen honey-cell was also placed in the nest near the pollen-lump. Liquid food, consisting of a mixture of common honey, rye-flour and water, was supplied to the bumblebees in a small tin container in a far corner of the box. Bright light was excluded from the nest by covering the top of the box with a sheet of dark red glass.

A. THE START OF A COLONY.

Though not showing any interest in the nest, both queens were producing considerable quantities of wax by May 27. This wax was scraped off and carelessly allowed to drop to the floor of the box. On June 13 almost a month since the queens were first confined, both queens suddenly seemed to take an interest in starting a colony. This interest was first manifested by their resting mostly on the pollen-lump, occasionally nibbling at the pollen, and buzzing excitedly when disturbed. For the next few days after this the queens were less active. On June 23, however, they showed renewed vigor, making during the night a honey-pot out of the accumulated and introduced wax, and also an egg-cell in the pollen-lump.

After this second start the activities of the two queens never abated. On June 24 one egg was found in the cell made on June 23, and two more empty cells had been constructed. On June 26 the two cells made on June 24 were closed over and each contained a single egg. Up to this time neither of the

two queens had ever seemed to mind the presence of the other, but from now on whenever the nest was disturbed, they often threatened each other without, however, ever engaging in actual combat. On July 2 larvæ were observed in the pollen-mass. They had probably emerged some days before, but as I did not care to disturb the queens, I had not examined these first few cells critically. It may be mentioned here that both the queens were still occupied with the nest, though the queen that was last introduced seemed to dominate the nest.

By July 10 the nest had progressed so far that I could remove the queens and photograph the nest, without the risk of causing the queens to abandon it. Here I may say that I believe it was the queen with the clipped wings that was the actual mother of the developing colony. As time progressed this latter queen more and more asserted her right over the colony, the other queen remaining listlessly about the honey-pot. Moreover, it seems hardly probable that a queen should start a colony and then calmly submit to its being monopolized by another, when queens under natural conditions usually fight over the nests. Again, from the beginning of the colony, the queen with the clipped wings had been the dominating figure.

On July 14 the larvæ began spinning their cocoons, more eggs were laid by the queen, and the nest promised well for the future. Frequently the queen could be heard making a purring noise, while brooding over the comb. On July 20 the first worker emerged, and by July 25 five more workers had made their appearance. The variation in the rate of emergence of these first few workers was mainly due to the egg-laying habits of the queen.

Of the later life-history of this colony little need be said. It may be mentioned, however, that later in the season the queen was accidently killed and the colony rapidly declined. The egg-laying habits, nest manipulations, wax-production, and other miscellaneous features were the same in this colony as described in my first article of this species ('17); with one exception.

The honey-pots in this nest, except for the one first constructed, were not so large nor were they so distinctly separated from the comb.

B. GENERAL FACTS OF INTEREST.

Prior to August 1, when the first queen was removed from the nest, neither queen had come to grief through the jealousy of the other. Sladen in his book on the "Humblebee" says that one of the queens, if two shared the same nest, killed the other about the time the first eggs were laid. Again, in this colony started with two queens, the first larvæ were reared to maturity without the addition of introduced workers.

III. Opening of a Field Nest of *Bombus auricomus*.

On September 6, 1917, Dr. J. W. Folsom and myself opened and removed a nest of *Bombus auricomus* of natural origin. This nest was found in a hollow cement block, the block being a part of the foundation of a small cabin. In order to remove the block and thus get the nest it was necessary to raise one corner of the cabin with automobile jacks. Upon removing the block we found that the bumblebee nest had been started in a mouse nest within the block. The bumblebees were very docile when the nest was removed, for instead of flying angrily from the nest, the most they did was to run excitedly about on the comb and buzz loudly.

A better protected or situated nest could hardly have been selected by a queen. An examination of this nest was valuable in that it afforded a comparison between a nest of natural origin and one established under more or less controlled conditions. Again, as this nest was taken in fall it was representative of the natural "climax" nest of this species.

A. NEST CONTENTS.

There were ten workers, three new queens and three males alive in the nest at the time of opening. Five dead workers were found in the debris of the nest. A careful search was made for the old queen, but no trace of her could be found. In addition to the above, several bumblebees which were not in the nest when it was opened, returned later and remained about the old nesting site for many days. No trace of the original wax-pollen honey-pot was found, or in fact any wax-pollen cells, except the egg cells. In two of the five dead

bumble-bee workers, I found the puparia of *Zodion obliquefasciatum* Macq. (Malloch det.). The nest was also infested by the phycitid moth, *Vitulas edmansii* Pack., which has been previously reported from the nest of *Bombus perplexus* Cress. by Franklin ('13).

B. LATER HISTORY OF THE COLONY.

After the removal of the nest to an observation box, one or more males emerged almost every day for two weeks, but no additional queens or workers. The males would stay in the nest for several days and then leave, perhaps returning and perhaps not. An attempt was made to secure the fertilization of the three queens by confining them with the males, but this failed. On October 9, two workers were still alive in the nest, but could scarcely move about. On October 12, these two workers succumbed to the increasing cold nights and the colony came to an end.

IV. Summary of the Life History.

The following summary of the important facts in the life history of *Bombus auricomus* is based upon a study of the two colonies in this paper, and also upon my previous account ('17).

1. The nests are usually established in this vicinity sometime between the middle of May and the middle of June.
2. The bumblebees of this species are of a docile disposition as compared with such a species as *Bombus pennsylvanicus* De Geer.
3. The colonies are of rather small size.
4. The workers sometimes lay eggs, which are capable of hatching.
5. The eggs are laid in separate cells, several of which may be adjoining, but the cell-individuality is never lost.
6. The larvæ continue to remain isolated from other individuals in the same stage of development.
7. The life-cycle varies in individual cases, but may be said to last for all sexes about three and one-half weeks.

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EXPLANATION OF PLATE III.

Fig. 1. Side view of a nest of *Bombus auricomus* Robt., of natural origin, on September 8, 1917, showing: *a*, perpendicular arrangement of the comb; *b*, usual wax-pollen covering used in forming a protective envelope about the comb. Reduced.

Fig. 2. Top view of a nest of *Bombus auricomus* Robt., of natural origin, on September 8, 1917, showing: *a*, cocoon partially filled with pollen; *b*, cocoon used for storage of honey; *c*, three egg-cells; *d*, uncapped cocoons. Reduced.